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TO:

DATE: 20 October 1956

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FROM:

**SUBJECT: Engineering Report, Configuration 73-C Three Axes
Stabilizer Prototype Tests**

Introduction

To test the operation of the 73-C Stabilizer a "breadboard" model of the 73-C Camera was constructed and tested. The breadboard consisted of all components of the 73-C Stabilizer, the Cager, the simulated mass of the 73-C Camera, a programmer and instrumentation.

The operating breadboard showed that the camera mass was stabilized far within required minimum rates. IMC rates were calibrated over required rates and within required tolerance.

Improvements were indicated in the gyro and electrical system because of a residual 30 c.p.a. signal which caused the torquing solenoids to vibrate.

The cager would not operate faster than the lowest required rate. More rigidity was required than the cager provided. A need for a stronger cager was indicated (or a captivator to grasp the camera firmly when not operating). Excess camera movement existed when uncaging occurred.

The first flight test of the breadboard was not successful. Although successful stabilization in pitch and roll axes was indicated, a poor electrical connection in the yaw gyro prevented yaw stabilization. The severe yaw movements reflected in pitch and roll axes and caused all instrumentation to be almost meaningless.

Further flight tests have not been made on the breadboard because 73-C Camera Serial No. 1 was near final production and components from the breadboard were required to complete it. Furthermore the information gained from ground test indicated many improvements necessary before completing No. 1 Camera.

Operation of 73-C Camera Breadboard

The camera mass and inertia was simulated by a steel structure. See figures 1 (side view) and 2 (end view with gyros). The mass was floated on a three axes gimbal. The three rate gyros sensing angular motion about the three axes are mounted on the wall of the structure. The camera mass is torqued about these axes by solenoids mounted on the gimbal. The gimbal, gyros, and solenoids can be seen in figure 2.

Mounted on the bottom deck of the breadboard are amplifiers required to operate the gyros and solenoids. The required power supplies are also mounted on this deck.

On the top deck of the breadboard is located the programmer, instrumentation gyros, and a 12 channel proportional recorder.

Test Results

Ground Testing

Stabilization (without Cager)

With the breadboard uncaged and the stabilizer operating, drift rates were checked in all axes with a transit and calibrated scale on the camera. Motion in all axes varied from one milliradian displacement in the seconds to one milliradian in more than thirty seconds. Specification requires less than 0.3 milliradians per second of drift.

The drift rate was tested also with rate gyros. The gyros indicated rates of drift below 0.1 milliradian per second but the outputs contained ripple components. The ripple frequencies were between 5 and 30 cps. The ripple was created from several sources. First the Programmer and motors caused vibrations to occur in the upper deck of the breadboard. Secondly, ripple occurred in some of the gyro outputs with no input. These components were known to the gyro manufacturers but were within the resolution guaranteed for the gyros. Thirdly, the sensing gyros of the stabilizer had a thirty cps residual signal. This has been investigated at the manufacturers (Reeves Inst. Co.) factory. They have no explanation for the effect. Notation of the spin motor within its bearings has been proposed as a possible cause.

The latter phenomenon was most troublesome because it caused the torquing solenoids to buzz. The compliance of the solenoid mount prevented the high frequency from being transmitted to the breadboard.

Cager Operation

The cager was operated at one cycle per 4 seconds. It could not be operated faster because the time required for caging was excessive. One cycle per 1.9 seconds is required.

The motion of the camera while caging was not damped during the caged interval. Hence movement continued until after uncaging. The time required to damp the uncaging movement was longer than would be available in faster operation.

Stabilization with Airframe Movement

A three axes rocking table was constructed to test the stabilizer with angular rates applied to the mount. With peak angular rates as great as 10 milliradian per second applied in each of three axes at a frequency of one cycle per four seconds, the residual camera motion was less than 0.3 milliradian per second with stabilization. Without stabilization the residual camera rate was at least two milliradians per second.

Cross Coupling

No evidence of cross coupling between axes was found.

Conclusions

1. The residual 30 cps frequency component must be eliminated. This has been done very successfully with a parallel T filter in the stabilization amplifier.
2. The solenoid mounting should be stiffer. This has been done. With the 30 cps gyro signals eliminated the stiffer mounting is very successful.
3. A new cager design is required.
4. Attempts to use an Autobalance to trim out vibrations in static balance were unsuccessful, and they will be until a better cager is made. Tests on Serial No. 1 Camera have since indicated an autobalance is unnecessary.

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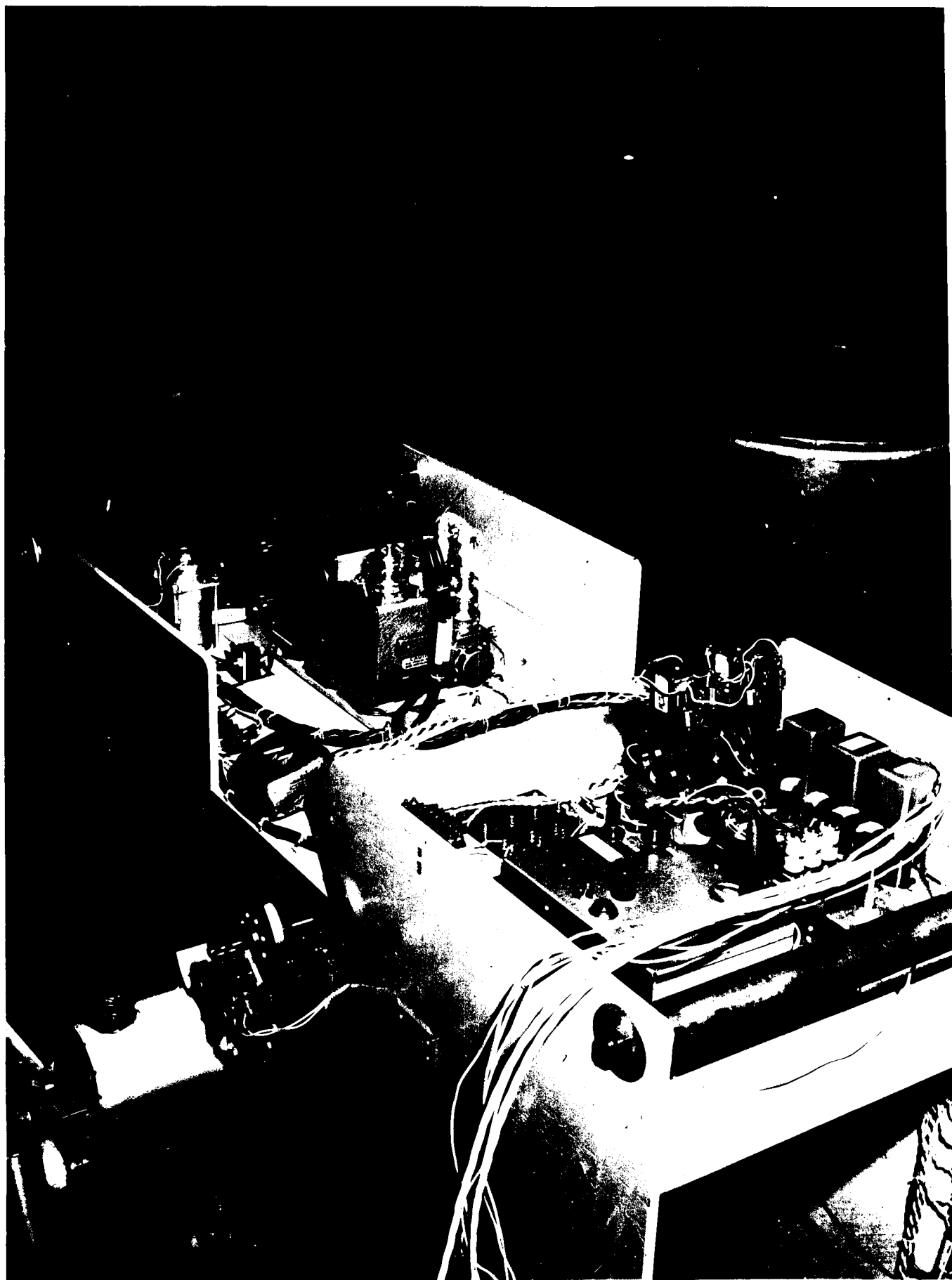


Figure 1

